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ABSTRACT

This paper attempts to merge specific psychological theories of knowledge acquisition, the impact of pictures on cognitive processes, and theories of effective pedagogical approaches to foreign language learning, in order to assess commercially available software for its effectiveness, specific impact on learning, and classroom uses. The first section discusses the theoretical framework of the project, including three questions key to the exploration: (1) Can the potential effectiveness or use of these software programs be systematically evaluated based upon a psychology of language learning? (2) What is the psychological impact of the linking of text, sound, and pictures; does the ability to do so through the use of multimedia somehow make the computer a more potent tool for learning than ever before; and does the way the program links these elements further determine how they impact the learner? and (3) Is it possible to articulate an integrated use of these tools within a curriculum based upon the answers to these questions? The second section examines the following commercially available software packages, and considers how they may be impacting the learner: "Talk Now!," "Learnware," "The Rhythm of French," "Transparent Language," "The Rosetta Stone," "French Your Way," "Encuentros", and "A la rencontre de Philippe." Contains 22 references. (DLS)

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# Creating a Psychological Foundation for the Evaluation of Pre-Packaged Software in Second Language Learning

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**Abstract**

For over three decades, scholars have been struggling to determine whether computers truly enhance foreign language learning and, more recently, specifically how. In this paper, we attempt to merge specific psychological theories of knowledge acquisition, the impact of pictures on cognitive processes, and theories of effective pedagogical approaches to foreign language learning in order to assess commercially available software for its effectiveness, specific impact on learning, and classroom uses. Within a psychological paradigm which includes an awareness of how mental models are formed, how domain knowledge enhances the process, and how images can impact upon learning against the backdrop of dual-code processing, an adherence to doctrinaire beliefs in one methodology can be broken down, leaving room for progressive pedagogical approaches which attempt to integrate what is valuable from cognitivist, behaviorist, and communicative approaches. Having made selection of method our first priority, we look at a variety of software packages currently available and consider how they may be impacting upon the learner.

## I. Theoretical Framework

The research in the psychology of language learning is staggering in its quantity and approaches. On top of this, for over three decades, scholars have been struggling to determine whether computers truly enhance foreign language learning and, more recently, specifically how. The clash of hyperbolic positivism versus dogmatic skepticism about whether or not computers are effective tools makes it imperative that scholars and teachers accurately and thoughtfully start to articulate goals and methodologies when multimedia, hypermedia or any media is integrated into any curricula. Carol Chapelle writes: "Advancements in the design and use of computer-assisted language learning (CALL) activities require that key questions about CALL be identified and effective research methods be used to answer them…[Second language] classroom research suggests the need for descriptive research documenting the nature of the interaction that learners engage in within various CALL contexts [Chapelle 97]." In this paper, we attempt to merge specific psychological theories of knowledge acquisition, the impact of pictures on cognitive processes, and theories of effective pedagogical approaches to foreign language learning in order to then assess commercially available software for its effectiveness, specific impact on learning, and classroom uses. Three questions are key to such an exploration:

1) Can the potential effectiveness or use of these software programs be systematically evaluated based upon a psychology of language learning?
2) What is the psychological impact of the linking of text, sound, and pictures? Does the ability to do so through the use of multimedia somehow make the computer a more potent tool for learning than ever before? And does the *way* the program links these elements further determine how they impact the learner?
3) Is it possible to articulate an integrated use of these tools within a curriculum based upon the answers to these questions?

The process of learning alone and the shifting terrain in our approaches to teaching are complex even without the complicating factor of selection of medium. It has been pointed out that in recent years, emphasis in language instruction has shifted to process, rather than product and to attaining communicative competence over and above learning structure [Puscak & Otto 97; Littlewood 92]. Language learning is increasingly considered to be a process in which set of habits or automatized skills are created which then become imbedded as mental models in the mind [Littlewood 92]. More and more studies of computers in learning are implicitly or explicitly based upon the understanding from cognitivist theories that the computer creates, acts upon and reacts from mental models [Seel et al. 89; Cousins & Ross 93; Mayer & Sims 94; Mayer & Gallini 90; Bernhardt 84; Snow 84; Masny 84]. A mental model can be loosely defined as a "construction of an internal model of the world" which is "persistent and stable" [Seel et al. 89]. On top of the layer of mental modes, there is the level of skill and control, according to Ellen Bialystok. "Language processing…is based on a set of two interacting subskills, or skill components. The skill components are called analysis of linguistic knowledge and control of linguistic

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processing. These skill components are part of the cognitive mechanisms for learning, organising [sic] information, and solving problems [Bialystok 91]."

In order to impact upon pre-existing mental models or to create a new mental model, domain-knowledge has been found to be important. Domain knowledge has been defined as pre-existing knowledge of a particular subject matter. In a study of how learners processed pictures of katagana and hiragana through observation of eye movements, it was demonstrated that when learners were exposed to the characters without any prior introduction, eye movements were random and processing apparently shallow. However, when they were given a general introduction to how characters are formed and read, their eye movements showed regular patterns which indicated perception of meaning and content within form [Koga & Groner 89]. This study again emphasizes an integrated approach to learning, in which lower-level and higher-level processes in learning can be accessed depending upon the learning context.

Karen Swan and Carla Meskill have postulated that a computer represents cognitive processes so habits of thought are internalized [Swan & Meskill 96]. The use of a computer program can build new mental habits and plans of lower- to higher-levels of complexity throughout an overall class plan, as well as doing so cyclically, depending upon areas where students may hit a plateau or need to regroup to focus on particulate skills rather than communicative competencies. This is consistent with Littlewood's holistic view of how language use works: "When we use language, we are constantly having to create new higher-level plans at the level of ideas, meanings, and conversational strategies. The effective execution of these plans depends upon a high degree of automaticity at the lower levels [Littlewood 93]." A common complaint among language teachers is how difficult it is to adapt materials developed independently of textbooks. However, if the goal is to bundle a variety of different types of exercises in order to immerse the learner in varied contexts and to provide varied and targeted communicative input, then any tool such as software, video, or an audiotape can enhance what is offered in a textbook. Modality must suit the method. "Sometimes the question arises whether a specific medium, as a result of its mode of presentation, may create certain symbols and codes in the domain of knowledge representation by favoring the storage of information in a format which is congruent to the modality of presentation [Seel 89]."

How do images enhance language acquisition or affect mental modes? This is particularly crucial in light of the capacity of digital media to provide more direct, varied, easily controlled and mediated visual input to support and enhance aural comprehension and use of the target language. It is illuminating to reflect on the fact that in the evolution of cognition, writing developed from sketches [Molitor et al. 89]. In a sense then, it could be said that as digital media infiltrate more and more of our communication and learning processes, we are returning to a dependence upon a cognitive tool predating writing. Innumerable studies have proven conclusively that pictures enhance learning, especially in high-ability learners. Stephen Krashen, who developed the natural learning theory of language acquisition, notes "whatever helps comprehension is important. This is why visual aids are so useful. Pictures and other visuals ...supply the extra-linguistic context that helps the acquirer to understand and thereby to acquire [Krashen 83]."

Articulating a psychological theory of how pictures affect learning, Sylvie Molitor and her colleagues echo Krashen's view: "Texts and pictures...visualize parts of reality which are not immediately present or accessible in one's direct experience" and are "mental models" in which "reality is represented in an analogous, predominantly imaginative form...Corresponding to their prior knowledge and their cognitive strategies, learners build up a specific knowledge structure based on the information obtained from texts and pictures [Molitor et al. 89]." This view is shared by G. Salomon who notes that when texts and pictures are combined, "they often determine how stimuli are perceived and processed [Salomon 89]." When studying a new language, a learner starts with very little, if any, prior knowledge. In the process of acquiring this knowledge, according to Krashen's theories of natural learning, the learner must "acquire...language by understanding input that is a little beyond [his] current level of (acquired) competence [Krashen 83]." Just as a child's knowledge base is increased by external stimuli, so images as teaching tools can push this envelope in direct and indirect ways.

One of the most obvious ways in which pictures interact with text is through modeling. Just as a learner might use a grammatical model to understand personal pronouns, so she might depend upon a picture to illuminate the content of a conversation in German. In the former example, modeling is being used as a skill-based or non-communicative learning exercise, while in the latter example, the modeling as exhibited by the picture can be used either for a task-oriented or communicative practice. Ultimately, both modalities serve to build up and reinforce increasingly complex layers of knowledge that can be tapped into when needed, consciously or unconsciously. But more than the function of images as models or for spurring language production by giving the students something to talk about using new forms, what seems particularly significant is the concept that pictures "activate schemata" and support comprehension. The implication may be that if a learner has built up a body of knowledge through a variety of skill-based and communicative practices, that images will lower what Krashen calls the affective filter or break down learner resistance to acquisition and production of new forms on a *neurological* basis.

This theory essentially postulates that the more modalities properly targeted, as is suggested in theories of dual-coding, the capacity for learning is expanded. According to dual-code theory, the learner uses two distinct information-processing systems—one that represents information verbally and one that represents information visually. For learning to be meaningful, there must be a connection constructed between the two [Mayer & Sims 94]. This means that it is better if material is presented in two or more formats to construct knowledge models promoting visual, verbal, and referential connections. When this is done, studies have shown that learning is likely to be more successful [Mayer & Gallini 90]. This idea is similar to Chun and Plass' speculation that text "represents information in symbolic structures of a language and is processed sequentially, that is, word by word or sentence by sentence. Pictures, on the other hand, convey their information by means of a visuo-spatial structure…and thus represent the subject matter by employing an analogy based on common structure properties and encode information parallel or simultaneously [Chun & Plass 97]."

Dual-code theories make clear how and why images can enhance learning. The next question is how pictures work specifically so that the appropriate modality can be selected. Molitor provides four functions of pictures in learning useful in discussing the impact of foreign language software on learning.

- In the representation function, "the picture overlaps the contents of a text…the picture is a redundant source of information to constantly check text comprehension by offering…a second opportunity for learning.
- The organization function of a picture "provides an organized, coherent, reductive macrostructure of the text content."
- The interpretation function "illustrates text contents which are difficult to understand (e.g. by analogies, visual metaphors, etc.)."
- The transformation function "offer a mnemonically useful form of recoding, being a kind of visual mnemonic. This is the function pictures often have in the 'keyword' or 'hook' technique for learning vocabulary in foreign language instruction [Molitar 89]."

Other studies have shown that visual and verbal processes can also compete with one another. It is therefore important to determine that the pedagogical motivation behind the combination of text and visuals is not creating conflicts in processing and retention of materials [Loew 95]. Robert Kozma theorizes that computers primarily have transformational capabilities, or the ability to make connections between symbolic learning and real world situations. "First, an important attribute of the computer is its ability to symbolically represent entities in ways that might inform mental models. They can graphically represent not only concrete objects but also formal, abstract entities that novices do not normally include in their models. Second, the computer has the important capability of being able to proceduralize the relationships among these symbols [Kozma 91]."

In a study researching the effectiveness of a program called *Thinker Tools* which teaches Newtonian mechanics, students who used the program scored significantly higher than the control group. In another study, students using a software program called the *Jasper Woodbury Series* also scored higher than the control group. According to Kozma, it was the computer's ability to model objects in motion in the *Thinker Tools* program Which enabled student to construct complex and dynamic mental models of the materials. In the case of the *Jasper Woodbury Series*, Kozma states that "the visual and social nature of the story, as presented with video [was] more likely to activate relevant situation-based prior knowledge so that students can use this to solve the problem. They are also more likely to connect their new learning to representations of situations as it is stored in memory. This will increase the likelihood that when similar problem situations are encountered, they will evoke an appropriate solution response. "By repeating the same kinds of analyses and solutions in multiple contexts or situations with very different surface characteristics but common underlying task demands, these learned solution strategies are connected to a variety of situation schemas in memory and this promotes transfer across a variety of subsequently encountered problem situations [Kozma 95]." Kozma concludes in another discussion on learning with media that these effects would be particularly true in foreign language learning [Kozma 91].

Vitor Duarte Teodoro reflects this emphasis on targeting a cluster of learning modalities. He calls for computer environments which "demand cognitive and metacognitive skills." Cognitive skills are defined as the ability "to manipulate and integrate information" and metacognitive skills as the ability "to regulate and control their actions and knowledge in order to build new knowledge." Extrapolating from this idea, Teodoro is interested in the development of exploratory programs which "allow students to get a strong degree of familiarization with an idea. With exploratory software, students can see many situations, explore what happens in different conditions, discuss what happens if they change conditions…When they become more familiar with new ideas, they can establish more meaningful relations with ideas they already have [Teodoro 1994]."

Within a psychological paradigm which includes an awareness of how mental models are formed, how domain knowledge enhances the process, and how images can impact upon learning against the backdrop of dual-code processing, an adherence to doctrinaire beliefs in one methodology can be broken down, leaving room for progressive pedagogical approaches which attempt to integrate what is valuable from cognitivist, behaviorist, and communicative approaches. Having made selection of method our first priority, the medium can

complement the learner and facilitate operations the learner is capable of performing and perform those which the learner cannot [Kozma 91 & 95]. Our view of media in learning can then be similarly integrated, holistic, and flexible as Robert Kozma notes:

> Specifically, to understand the role of media in learning, we must ground a theory of media in the cognitive and social processed by which knowledge is constructed, we must define media in ways that are compatible and complementary with these processes, we must conduct research on the mechanisms by which characteristics of media might interact with and influence these processes, and we must design our interventions in ways that embed media in these processes [Kozma 95].

## II. Putting Theory to Work: Evaluating Commercially Available Software

Software currently available on the market for educational or mass-market use stretches across a wide spectrum of quality and thoughtfulness in design. When initially considering the use of any type of media which uses video or pictures, it is important to know that studies have shown that audio support has no positive effect on *retention* of words [Puscak & Otto 97]. This is probably true because it is postulated that processing of spoken and written text involves similar cognitive processes because they are symbolic representations of information [Chun & Plass 97]. On the other hand, as we have already said, other studies have shown conclusively that pictures increase recall if they illustrate information central to the text [Kozma 91 & Weidenmann 89]. The most basic computer programs developed now in foreign languages mainly differ from traditional audiocassettes in their attempt to provide moving or repetitively appearing pictures to model the text and act as a visual hook for memorization. Therefore, even when the capability of multimedia is used only at this basic level, it follows from the research that these programs might be slightly more successful than a similar audiocassette exercise with only oral input. Since such programs are generally designed for beginning learners who have little domain knowledge of the subject matter, they will be more successful if they focus on smaller units of sound and speech.

Programs such as *Talk Now!* and *Learnware* fall into this category and explicitly work on lower-level processes such as pronunciation and aural recognition of words. In *Talk Now!* multiple exercises around the same content in which the same pictures appear and reappear seem to be an attempt to reinforce and stabilize a learner's basic knowledge base of pronunciation and intonation, and, in the case of the less-commonly-taught languages, such as Russian, of recognition of the non-Latin alphabet, a huge cognitive leap in and of itself for which a whole new mental model must be created. Especially in the case of *Learnware*, which provides eight "Teaching" segments on pronunciation (and character writing for the non-Latin scripts) and eight "Games" where the student works with the knowledge acquired through teaching, the learner is being immersed in varied contexts, thus providing varied communicative input. The fact that studies have also shown that learners adjust their behavior according to the amount of instruction they receive would lean in the favor of programs providing many exercises [Hannafin 95 and Vosniadou 94]. Additionally, in the case of *Learnware Chinese*, the learner is guided into a study of pronunciation with an introduction to the Chinese tonal system. The intention is clearly to acclimatize the learner to listening with a different intent at the outset by creating the minimal needed level of domain knowledge.

Other visual hooks used in pronunciation exercises are included in *Learnware* and *The Rhythm of French*. The movement of lips, tongue, and breath are modeled through moving diagrams and can be clicked on repeatedly so that the learner can attempt to imitate the action of the model. In *The Rhythm of French*, focus on pronunciation is robust, with extensive explanatory text used to create domain knowledge, audio to allow learners to hear the differences as the text is read aloud to them, and multiple exercises involving the diagrams and other mnemonic hooks to reinforce aural recognition and production. Indeed, *The Rhythm of French*, a three-volume CD set, uses the benefits of multimedia to complete advantage with probable high learner success in this area high, even with low-ability learners. What is the most powerful about this program is how much control the learner has over all the material and the pace of instruction. In this sense, it is capitalizing on the fact that "Hypermedia supports constructionist views of learning, which hold that learning takes place when students actively and collectively build internal knowledge structures." In the case of *The Rhythm of French*, as Swan points out, this process has been made "explicit, thus increasing the likelihood that students will internalize what they learn [Swan 96]."

Many programs at various levels of difficulty use audio waveforms to graphically illustrate the audio pattern of speech. The program *Transparent Language* calls this feature the "sound palette." The learner is expected to record her own voice and attempt to match the wave form of the native speaker's voice, an example of the organization function in which the image provides summary of the content. In addition, by providing additional visual input to match the aural input, these programs are conceivably creating "additive effects in recall" by coding the information through the verbal and nonverbal systems. As Chun and Plass point out, "Information in a symbolic representation is stored in the verbal system; information in a nonverbal, analog representation is stored in the nonverbal system [Chun & Plass 97]."

One of the few software programs designed with an awareness of how multimedia can capitalize on the psychological processes of language learning is *The Rosetta Stone*. Indeed, because of this fact, *The Rosetta Stone* is perhaps one of the more powerful learning tools on the market today. Its developers explicitly based their methodology on Krashen's theories of natural learning. In their promotional flyer, they write: "the best model for learning a new language is the natural way in which we learned our native language. This idea has been espoused by a school of thought that emphasizes comprehension of spoken language as the first step to acquiring fluency. This is called 'the comprehension approach' or 'the natural approach'." *The Rosetta Stone* provides the learner with gradated comprehensible input, always pushing the envelope of the learner's knowledge just a little above what they have just acquired. Their flyer reads: "The native language is learned by hearing simplified speech in a context which provides the cues that make this speech comprehensible. This context also provides immediate reinforcement to the child...[*The Rosetta Stone*] works in the same way. It uses thousands of carefully selected pictures to create contexts where the meaning is clear. The program elicits the student's response and gives instantaneous feedback, confirming the comprehension that takes place."

*The Rosetta Stone* is designed directly from the concept that media can be a mediator of information or is an 'external model' of reality. This program could be said to be "activating subjective knowledge about the significant facts and the available modes of presentation...Thus external and mental modeling...is intended to produce a plausible (subjective) explanation of a particular appearance existing in the external world. External modeling is intended to evoke cognitive processes in itself in another (known) recipient of information, to facilitate or to cause mental modeling [Seel and Strittmatter 89]." For instance, in the first unit of the Russian version, students are exposed to individual words. Then each lesson increases in grammatical and syntactical complexity. Each unit can be worked with in a variety of different formats: sound with pictures, sound and text with pictures, text and pictures, and so on. In other words, the learner or teacher can select the modality to be emphasized depending upon the skill to be acquired and activated: aural, oral or reading comprehension. A selection of emphasis can also be based upon learning styles: Is the learner visually oriented? Does text help them understand spoken language at the outset? Do they want to work on becoming more accustomed to the new alphabet and spelling rules?

The language in *The Rosetta Stone* is consciously decontextualized or disembedded in an external context in order to affect deeply the internal model. By gradually wearing away the affective filter, or lowering the learner's resistance to the activation of new knowledge structures in communicative contexts, new communicative plans are replaced and created. With the new schemata in place, the learner can then extrapolate grammar in similar structures. For instance, *The Rosetta Stone* for Russian provides a series of exercises on the genitive declension using a small selection of adjectives and nouns. The material, presented amodally with increasing levels of complexity in each segment, gradually allows the learner to build lower- to higher-level skills. "Identifying needed information and disembedding it from a context is an important component of learning to solve problems and this ability contributes to successful transfer and performance in subsequent real-world situations [Kozma 95]." Eventually, when the new case is needed, having been disembedded for the purpose of creating an internal model in relationship to other structures and forms, it can be activated in communicative scenarios in direct relationship to other components of language structure relevant to meaning.

This process occurs because of the unconscious associations established through the use of text, sound, and pictures. The pictures in *The Rosetta Stone* fulfill a "representational function": they support the initial process of comprehension by helping the student link text and sound with a picture. Once the necessary connection is made between sound, text, and picture, then the image acts in a transformational way, becoming a mnemonic or hook leading the student repeatedly back to the previously imprinted knowledge. The active involvement of the learner in selecting pictures to match text and sound also successfully hooks especially the low-spatial ability learner who has been shown to "only be able to keep referential connections when visual and verbal information are presented simultaneously [Mayer 94]."

Such an active and complex engagement of the picture in the learning process in these programs is unusual. In many programs, pictures serve no purpose other than to illustrate the overall content of a dialogue, much as a picture in a book might do, and seem to be thrown in as an afterthought to the pedagogy, rather than as central to it. In a program called *French Your Way*, each "Study Conversation" has a picture illustrating the action in the dialogue. Although the picture technically serves an organization function, learning at the level of internal models are not being significantly helped or hindered by the pictures because the dialogues are relatively complex. In a Spanish program developed by Holt, Rinehart, and Winston called *Encuentros*, the pictorial backdrop is clever, but seems to be more illustrative than interpretive or transformational. In short, the power of multimedia is in its ability to use images, whether static or in motion, as a recoding device, as illustrative of difficult to understand content, or as representative of unknown content. What is lacking in *Encuentros* and *French Your Way* when considering what multimedia is capable of doing is that the pictures are not focusing the reader's attention on certain aspects of the information, thus improving the chance that the information is processed. Nor are they supporting the reader's building an internal connection among units of information

presented or building connections through the images between the ideas in the text into existing mental models [Chun & Plass 97].

However, the strength of *French Your Way* and *Encuentros* is the degree of control given to the learner to determine different outcomes within established scenarios, such as "Dining Out" in the former [Vosniadou 94 & Snow 96]. They are attempting to use the computer to provide as real a communicative scenario as possible where higher-level processes are completely engaged. Another very popular and pedagogically successful program called, *A la rencontre de Philippe*, also does this by allowing learners to accompany the protagonist, Philippe, on a journey through Paris to find a new apartment. The story is videotaped and learners can determine the outcome of the story depending upon their choices from a multiple-choice menu offered at each juncture in the story. It is in *Philippe* that we see the power of digital media to provide as complete an immersion experience as possible through the use of video and random access leading to use of higher-level processes. It is exemplary of how "the visual and social nature of the story, as presented with video, is more likely to activate relevant situation-based prior knowledge so that students can use this to solve the problem...By repeating the same kinds of analyses and solutions in multiple contexts or situations with very different surface characteristics but common underlying task demands, these learned solution strategies are connected to a variety of situation schemed in memory and this promotes transfer across a variety of subsequently encountered problem situations [Kozma 95]."

We are all aware that the best way for learners to acquire a second language is visit a country where that language is spoken and to experience the stress of needing to communicate actively. Most of our students who return from overseas come back far more fluent in all or some of the four basic skills depending upon their individual strengths and weaknesses: aural and oral comprehension, reading and writing. In *Philippe*, the images presented not only enhance or support comprehension, but in fact engage the learner in as real-life a conversation as possible. Learners are able to read and interpret various non-verbal and sociolinguistic clues to extrapolate meaning, just as they would in a real-world conversation. Vosniadou wrote that approaches in computer-assisted-language-learning were needed which would "emphasize the need to construct learning environments that engage students in culturally meaningful, purposeful and authentic activities that make deliberate use of the physical and social context... and which allow them to experience higher-level processes [Vosnaidu 94]." *Philippe*, *Encuentros*, and *French Your Way* attempt to do this with relative success.

Other features found to be empowering in the learning process include interactive pages, construction tools, note-taking capabilities, nonlinear access to background information, and open-ended questioning [Swan 96]. Programs like *Transparent Language*, *CineInteractive*, *French Your Way*, and *CyberBuch*, a CD on German literature, provide some combination of the above elements. In *French Your Way*, in addition, learners can also control the speed of speech in addition to having access to textual help when something is not understood. This latter feature is consistent with studies suggesting "that annotating lexical items with different modes of information presentation has positive effects on vocabulary acquisition [Chun & Plass 97]." *Transparent Language* which provides authentic literary texts replete with grammatical and cultural notes, annotations, translations of the entire text, a dictionary, various games emphasizing grammar, vocabulary, and pronunciation, and either a slide show or a video accompanying each text, is a very successful program probably because of its multi-layered design. When learners can approach material in a variety of different ways depending upon individual preferences and needs, it has been shown the deeper the level of knowledge acquired [Hannafin 95].

## III. Conclusion

It is striking that even in the past six years, research on the effectiveness of computer-assisted learning has increased dramatically. Whereas studies in the seventies and eighties were largely inconclusive as to the effectiveness of computer assisted learning, as the technologies have become more powerful, so has their potential *and* proven impact on learning in many disciplines. As Puscak and Otto point out, current technologies have created a "paradigm shift" that "will challenge traditional definitions and assumptions about the role of the student, the teacher, and the print textbook in language study. The basis for such a challenge is anchored in the prospect that multimedia can provide self-contained instructional experiences in a way that non-interactive media cannot [Puscak & Otto 97]."

Many of these software programs can be used independently or as a supplement to regular classroom instruction, giving the learner more control over the learning process than ever before. In addition, the wide array of modalities used to impact upon knowledge acquisition through a variety of different means promises to make more multidimensional what can be done in an ordinary classroom with just a textbook and a single speaker of the target language. These analyses of software are only meant to be suggestive; the next step would be to initiate studies testing these theories. We anticipate that such focused research methods will show that

these tools are even more powerful than we had originally hoped and will dramatically change the ongoing dialogue about the effectiveness of the new technologies.

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